Arctic Ice Thickness: State of the Arctic Report

Jacqueline A. Richter-Menge[1] and Jim Overland[2]
[1] US Army Engineer Research Development Center, Cold Regions Research and Engineering Laboratory, Hanover, NH
[2] NOAA/Pacific Marine Environmental Laboratory, Seattle, WA

PROJECT SUMMARY

The objective of this work is to directly support NOAA's Program Plan for Building a Sustained Ocean Observing System for Climate by expanding current efforts to monitor and document the state of the ocean to include the Arctic Ocean.

Recent observations are consistent in their indication that the Arctic region is undergoing significant environmental changes caused by a general warming of the climate. The heightened sensitivity of this environment is due, in part, to strong feedback processes that exist over both the ocean and land and are unique to this region. These amplifications create an environment that acts both as an indicator of climate change and as a potential amplifier of climate change. Because of this and the key role the polar regions play in determining the global climate, it is important to describe and to understand the state of the Arctic.

FY2006 ACCOMPLISHMENTS

- Conducted workshop to assist in formulating the State of the Arctic report 24-26 October 2005 at the Woods Hole Oceanographic Institute, Woods Hole, MA.

The workshop featured invited presentations by team members on the state of key atmosphere, ice, ocean and land parameters, as well as small discussion sessions. Lead authors for each section of the report, Richter-Menge (CRREL: Sea ice), Overland (NOAA PMEL: Atmosphere), Proshutinsky (WHOI: Ocean) and Romanovsky (UAF: Land) were joined by a science advisory team. The science advisory team consisted of 9 national and international Arctic experts from universities and government laboratories. Input from the workshop determined the observations highlighted in the State of the Arctic Report.

- Completion, publication and dissemination of State of the Arctic Report

On November 13, 2006, a NOAA report on the state of the Arctic will be released. The report represents the consensus of a team of 20 international scientists, covering observational data from 2000-2005. It highlights recent trends in physical components of the Arctic system, including the atmosphere, ocean, sea ice cover, and land. The observations presented in the report show convincing evidence of a sustained period of warming in the Arctic and the effects of that warming on environmental conditions such as sea ice extent and vegetation. While the report highlights a general warming of the Arctic during 2000-2005, there are a few indications that some elements of the physical system, such as the central Arctic Ocean and some wind patterns, are returning to environmental conditions more typically observed from 1950-1980.

The executive summary of the report is provided in the appendix.

Portions of the State of the Arctic Report appeared in BAMS Annual State of the Climate Report and OCO Annual State of the Ocean Report.

NOAA's Public Affairs Office will provide a press release and hold a media telephone conference on the findings of the report on November 16, 2006.

- Initiation of a web-based version of State of the Arctic Report

As a first step in completing this deliverable, an electronic version of the State of the Arctic Report has been posted on NOAA's Arctic Theme Page (http://www.arctic.noaa.gov/). The observations in the report will serve as a basis for a separate educational outreach section directed at the general public that will present information on the changing Arctic in a clear and accessible fashion. The web-based version of the report will be updated, at least annually, to provide a current summary of conditions in the Arctic as a function of climate variability.

- Incorporate data from in situ observation platforms into the International Arctic Ocean Observing System (iAOOS), which will be a subcomponent of the NOAA Integrated Ocean Observing System.

During FY2006, 5 Ice Mass Balance (IMB) buoys were deployed in the Arctic Ocean to monitor changes in the thickness of the ice cover as a function of atmospheric and oceanic forcing. These buoys were deployed in conjunction with other international programs that form the basis of the developing iAOOS including:

- North Pole Environmental Observatory (http://psc.apl.washington.edu/northpole/)
- Beaufort Gyre Observatory (http://www.whoi.edu/beaufortgyre/)
- DAMOCLES (http://www.damocles-eu.org/)
- International Arctic Buoy Programme (http://iabp.apl.washington.edu/)

Background and data from the IMBs is available at: http://www.crrel.usace.army.mil/sid/IMB/index.htm

APPENDIX

STATE OF THE ARCTIC REPORT: EXECUTIVE SUMMARY

This State of the Arctic Report presents a review of recent data by an international group of scientists who developed a consensus on the information content and reliability. The report highlights data primarily from 2000 to 2005 with a first look at winter 2006, providing an update to some of the records of physical processes discussed in the Arctic Climate Impact Assessment (ACIA 2004, 2005). Of particular note:

- Atmospheric climate patterns are shifting (Figure 1). The late winter/spring pattern for 2000–2005 had new hot spots in northeast Canada and the East Siberian Sea relative to 1980–1999. Late winter 2006, however, shows a return to earlier climate patterns, with warm temperatures in the extended region near Svalbard.

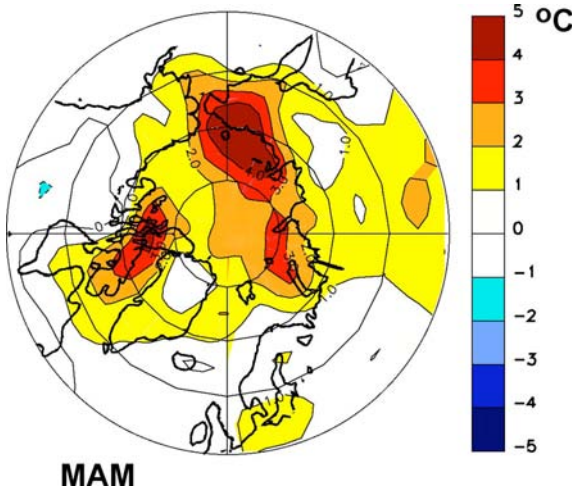

Figure 1. The Arctic system generally shows signs of continued warming, as illustrated in this northern hemisphere map of springtime (March-April-May, or MAM) surface air temperature anomalies for 2000–2005 that differ from earlier temperature patterns in the 20th century. Yellow and red indicate temperatures at least 1°C above average relative to a 1968–1996 base period.

Figure 2. Loss of sea ice and warmer ocean temperatures, highlighted in this report, have favored the pollock fishery in Alaskan waters. (Bryan & Cherry Alexander Photography.)

- Ocean salinity and temperature profiles at the North Pole and in the Beaufort Sea, which changed abruptly in the 1990s, show that conditions since 2000 have relaxed toward the pre-1990 climatology, although 2001–2004 has seen an increase in northward ocean heat transport through Bering Strait (Figure 2), which is thought to impact sea ice loss.

- Sea ice extent continues to decrease. The sea ice extent in September 2005 was the minimum observed in summer during the satellite era (beginning in 1979), marking an unprecedented series of extreme ice extent minima beginning in 2002 (Figure 3). The sea ice extent in March 2006 was also the minimum observed in winter during the satellite era.
- Tundra vegetation greenness increased, primarily due to an increase in the abundance of shrubs. Boreal forest vegetation greenness decreased, possibly due to drought conditions (Figure 4).

Figure 3. The report describes a continued reduction in the extent of summer sea ice cover which has recently benefited ship-based operations in this region. (Photo courtesy of Jeremy Harbeck.)

Figure 4. Observed increases in drought-related conditions in the boreal forests may have contributed to the increase in major wildfires over large parts of northern Alaska during the last two summers. (Photo by Mike McMillan, Spotfire Images.)

- There is increasing interest in the stability of the Greenland ice sheet. The velocity of outlet glaciers increased in 2005 relative to 2000 and 1995, but uncertainty remains with regard to the total mass balance.
- Permafrost temperatures continue to increase. However, data on changes in the active layer thickness (the relatively thin layer of ground between the surface and permafrost that undergoes seasonal freezing and thawing) are less conclusive. While some of the sites show a barely noticeable increasing trend in the thickness of the active layer, most of them do not.
- Globally, 2005 was the warmest year in the instrumental record (beginning in 1880), with the Arctic providing a large contribution toward this increase.

Many of the trends documented in the ACIA are continuing, but some are not. Taken collectively, the observations presented in this report indicate that during 2000–2005 the Arctic system showed signs of continued warming. However, there are a few indications that certain elements may be recovering and returning to recent climatological norms (for example, the central Arctic Ocean and some wind patterns). These mixed tendencies further illustrate the sensitivity and complexity of the Arctic physical system. They underline the importance of maintaining and expanding efforts to observe and better understand this important component of the climate system to provide accurate predictions of its future state.